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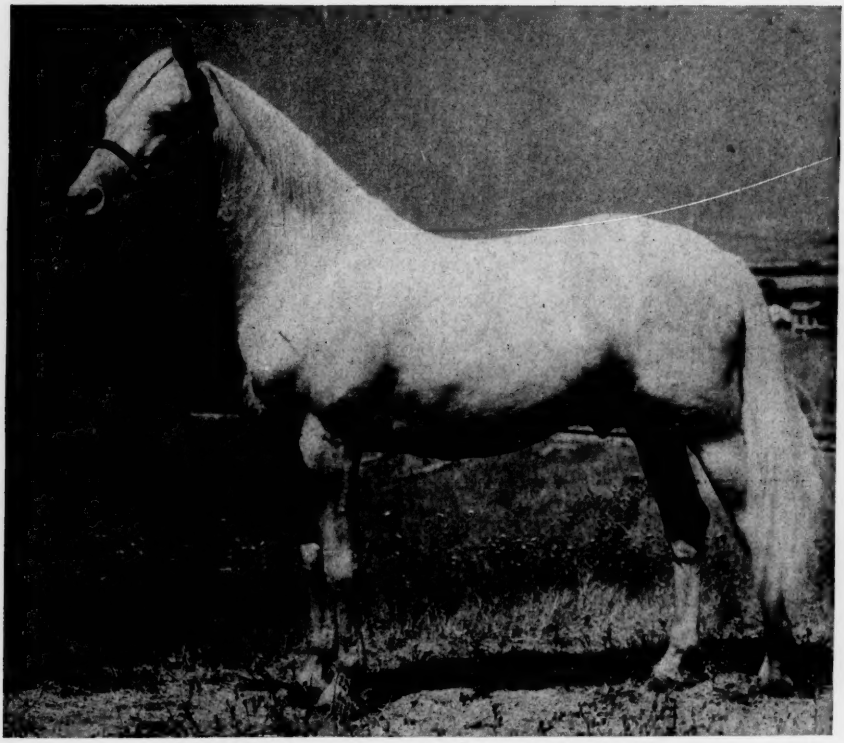

CREMELLO SIRE—HALF A PALOMINO
(SEE PAGE 35)

Natural Selection of Chromosomal Types

Indeterminate Growth in Maize

Production of Polynucleate Cells

Artificial Insemination Comes of Age

VOLUME 37 . FEBRUARY, 1946 NUMBER 2

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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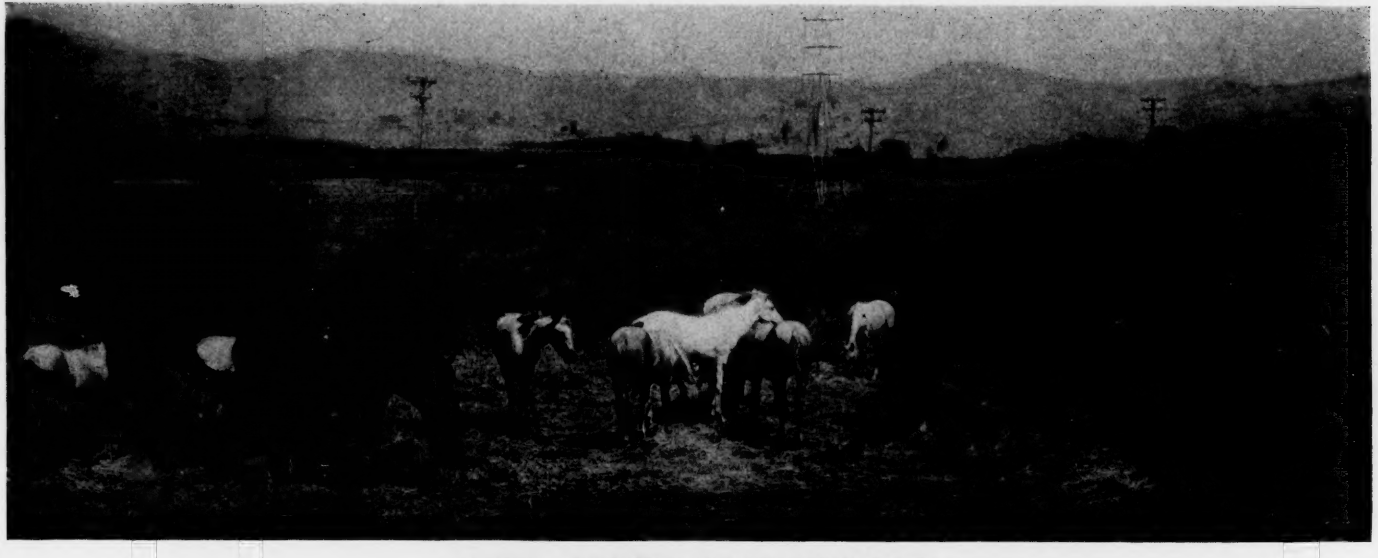


"ALBINO", PALOMINO AND BUCKSKIN COLTS

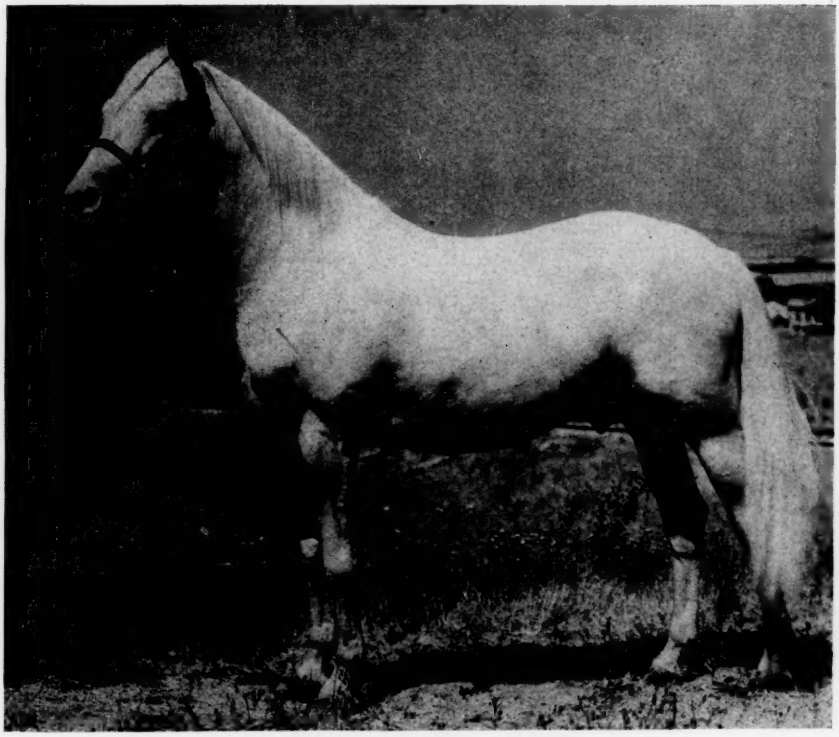
Figure 1

Eight colts sired by the "albino" stallion, Algiers, with their dams—five chestnuts, two bays, and one Palomino. Of the colts, six are Palominos, one is an albino like its sire, and one is a buckskin. The distribution of coat colors among the colts confirms to the hypothesis that Palomino coat color is conditioned by a heterozygous gene constitution and is of the genetic formula *Dd bb*.

GENETICS OF THE PALOMINO HORSE

Confirmation of the Salisbury-Britton Hypothesis

W. E. CASTLE
University of California, Berkeley



"ALBINO" STALLION, ALGIERS

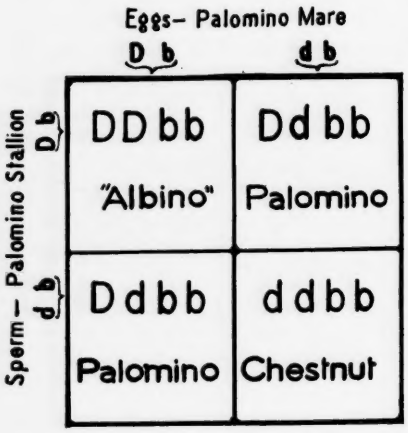
Figure 2

The pink skin and blue eyes of this stallion are due to a dominant dilution gene, not to a recessive gene for albinism. He is also homozygous for the recessive non-black allele of the *B* gene. He will produce only Palomino offspring when mated to chestnut mares, but half his colts by Palomino mares will be "albinos" like himself.

IN 1941 (*Jour. Hered.* 32) Salisbury and Britton made an important contribution to our knowledge of horse genetics by showing the Palomino coat color to be an unfixable heterozygous character, like the blue Andalusian plumage of the fowl. A Palomino horse has a golden yellow coat color, but with the mane and tail much lighter — almost white. It is not a true breeding color type. When Palominos are mated with each other, about half the colts on the average will be Palominos, and the remaining half will be about equally divided between chestnuts and so-called albinos. The colt population produced will thus consist of 1 albino : 2 Palomino : 1 chestnut. The albino type will be true

breeding when mated with its like, as will also the chestnut, but the Palomino type mated with its like will continue to produce all three types in the ratio 1 : 2 : 1. Such are the findings of Salisbury and Britton based on records of numerous practical horse breeders. These authors avoided the use of genetic symbols, which however it might be helpful to use to clarify the discussion. They showed that a Palomino is heterozygous for a dominant dilution factor (which we may call *D*) and homozygous for brown (*b*) the main gene characteristic of all chestnut horses. The genetic formula of a Palomino would accordingly be *Dd bb*, in which *D* stands for dilution, *d* stands for the supposed recessive allele of *D*, i.e., non-dilution, and *b* stands for brown pigmentation.

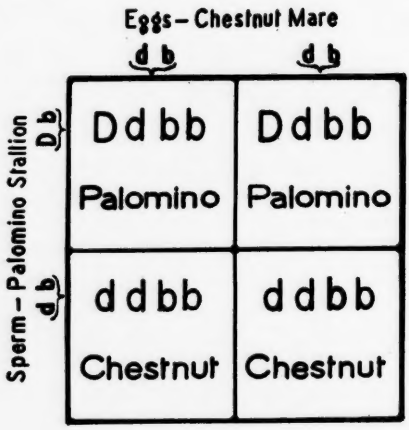
In a mating of Palomino with Palomino the gametes (eggs or sperm) of the parents will be as follows:



The so-called albino is known also in the southwestern United States as a "cremello." It is not pure white in color but very pale cream, as is easily seen in an animal having a star in the forehead or a blaze of clear white. Its skin is pink and eyes pale blue, in extreme cases with only a rim of dark pigment round the edge of the iris. Salisbury and Britton show a photograph of such an albino horse in their Figure 4. An animal of like genetic constitution is shown in Figure 2 herewith.

Salisbury and Britton further showed that a heterozygous dilute horse which has *B* (black pigment) rather than *b* (brown) in its genetic make-up, is of a buckskin or dun color, being like the Palomino of a light cream body color, but having a black rather than a whitish mane and tail. Its genetic formula would be *Dd BB* or *Dd Bb*.

If a Palomino (*Dd bb*) is mated to a chestnut (*dd bb*), half the colts would on the average be Palomino, half chestnut:



If an albino (cremello), *DD bb*, is mated to a chestnut, *dd bb*, all the colts should be Palomino for the sperm of an albino stallion would be all *Db* and the eggs of a chestnut mare all *db*. Only one combination type would result, viz., *Dd bb*, Palomino.

Three Ways to Produce Palominos

It follows from the foregoing that Palomino colts may be produced by three different types of mating, viz.,

(1) Palomino × Palomino producing 50% Palomino colts;
(2) Palomino × chestnut producing 50% Palomino colts;
(3) Albino (cremello) × chestnut producing 100% Palomino colts.

Other things being equal the third type of mating is twice as effective in the pro-

duction of Palomino colts as either of the others.

Salisbury and Britton presented evidence that the third type of mating (albino × chestnut) was effective in the production of Palomino colts sired by the albino stallion shown in their Figure 4, p. 257. Further verification is afforded by the experience of Mr. Frank L. King of Lafayette, California, in producing his 1945 crop of Palomino colts. The sire used was the stallion Algiers shown in Figure 2 and the dams were five chestnut mares, two bay mares, and one Palomino mare all shown with their colts in Figure 1. The five chestnut mares produced each a Palomino colt, as expected. One of the bay mares produced a buckskin colt (*Dd Bb*) as would be expected if she transmitted *dB* to her colt. The other bay mare produced a Palomino colt indicating that she was heterozygous for brown (*dd Bb*) and that she transmitted the *db* combination to her colt. The Palomino mare produced an albino colt (*DD bb*), the expectation being either an albino or a Palomino, since the sire would transmit *Db* and the dam either *Db* or *db*. In all eight colts the theoretical expectation was completely realized.

In the center of Figure 1 are seen three of the Palomino colts and the albino, whitest of the group. Behind the albino, projecting above its neck, is seen the rump of the Palomino mare, dam of the albino. At the extreme left in the picture is seen a fourth Palomino colt, its dam being the chestnut mare Chiquita nearest to the observer to the right of the colt. Between and behind them may be seen the hindquarters of the buckskin colt with black tail switched forward against its flank, the rest of the body being hidden behind Chiquita. The bay dam of the buckskin colt stands just beyond the colt in the picture. The other two Palomino colts are seen to the right of the central group, one fully shown beside its bay mother, the other almost wholly hidden behind its chestnut mother at the extreme right of the picture. The top of the colt's head and neck is shown over the dam's head.

Horse breeders now have available a reliable method for the production of Palomino colts in quantity, but to secure the highest quality in the colts the greatest care must of course be exercised as regards conformation, size and temperament in the animals selected as breeders. The character of the albino stallion will be especially important and at present we have no basis for estimating what will be the best genetic constitution of the albino parent, except that it must include homozygosity for *D* and *b*, i.e., *DD bb*.

Dominant White

Salisbury and Britton recognize the existence of a second type of white horse also popularly known as albino, which they designate *dominant white*. A white stallion of this type will produce white colts by mares of any color type whatever. We may call the gene responsible for this mutation *W*, epistatic to all other color types. A homozygous dominant white individual (*WW*) has not as yet been shown to exist. All stallions extensively tested produce colored as well as white colts, presumably in a 1 : 1 ratio. This leads us to think that dominant white is probably lethal when homozygous in horses as a similar dominant white mutation is in mice.

Concerning the two types of so called albino horses, Salisbury states p. 239, "there is no basis for the belief that they are the same character." Nevertheless it seems quite possible that they may be different alleles of one and the same mutant gene, like the albino alleles of rodents some of which are colorless, others quite well pigmented. Both white mutations in horses are dominent but one (*W*) much more strongly so than the other (*D*). A genetic test as to whether they are or are not alleles could easily be made by crossing the two, as for example by mating a cremello stallion (*DD bb*) to a dominant white mare.

If *D* and *W* are alleles, they represent different forms of one and the same genetic locus and are interchangeable at that locus. If this is true, in a cross between a cremello stallion (*DD bb*) and a dominant white mare (*Ww bb*) only

two genetic loci are involved. An F_1 white stallion will be heterozygous for one locus *D/W*, and homozygous for the other *b/b*. His gametes will take one gene from each pair, and so will be either *Db* or *Wb*. Chestnut mares (*dd bb*) will form only one type of gamete (*db*). Two and only two genetic combinations can result in matings of the type under discussion, viz., *Dd bb* (Palomino) and *Wd bb* (dominant white), equal numbers of each being expected.

If *D* and *W* are not alleles, the view expressed by Salisbury, then three genetic loci are involved in the cross between an F_1 white stallion and chestnut mares. His genetic formula will be *Dd Ww bb*, a heterozygous state existing at two loci *D/d* and *W/w*, the third locus being homozygous for *b*, viz., *b/b*. His gametes will be of four possible types, expected to occur in equal numbers, viz., *DWb, Dwb; dWb,* and *dwb*. In matings with chestnut mares (triple recessives, *dwb*), the four classes of colts expected would be respectively: (1) dominant white, (2) Palomino, (3) dominant white, and (4) chestnut. On the average there should be 2 dominant white : 1 Palomino : 1 chestnut colt.

On the hypothesis that *D* and *W* are alleles, the test cross mating of an F_1 stallion with chestnut mares should produce 50 per cent dominant white colts and 50 per cent Palomino *and nothing else*.

On the hypothesis that they are *not* alleles but mutations of distinct genes, the cross should produce 50 per cent dominant white colts and the remaining colts should be half Palominos and half chestnuts. The production of a single chestnut colt in such a mating would prove the three-locus hypothesis correct.

✦

HEREDITARY HYPOPLASIA IN CATTLE

Hereditary Forms of Sterility in Cattle: Biological and Genetical Investigations, I, K. Eriksson (*Lund, Sweden: Håkan Ohlssons Boktryck., 1943, pp. 155, illus. 10*).—Sex-gland hypoplasia seems to be an anomaly characteristic of improved Highland cattle. A circular tour was made of existing Highland breeding centers, and about 6,000 ♂♂ and ♀♀ were clinically examined for the existence of hypoplasia. The testicles of about 70 slaughtered bulls and the ovaries and uteri of 40 cows from the Oslo slaughterhouse and cooperative abattoir were examined histologically without finding any cases of hypoplasia, but it is not entirely unknown in other breeds from various regions and in several types of animals. In testicle hypoplasia, normal spermatogenesis does not occur. The epithelium layers of the seminal ducts and the follicles of the ovaries were more or less undeveloped, with a low percentage of fertilization occurring. Thus, testicular and ovarian hypoplasia may vary in degree. Differences in the testicles and ovaries of the two sides are taken to indicate lateral hypoplasia. In the 135 normal ♀♀ examined, the left ovary was heavier than the right in 52 cases, with equality in 16 cases, and in 67 cases the right ovary was heavier than the left. Differences between the size of the two sides become more evident as age advances in both sexes. The localization of hypoplasia, especially in the left side in the Highland breed is a typical fundamental characteristic of the breed. Double-sided hypoplastic ♀♀ showed characteristic abnormalities in the primary and secondary sexual characters. One-sided hypoplastic bulls did not show as much development as normals, but the differences were small and not significant. One-sided hypoplastic cows had somewhat better body development than normals, except for height at withers. Differences were also small and not significant. Double-sided hypoplasts in both sexes are usually completely sterile, producing no viable gametes, although sexual instinct and copulation were at least normal. One-sided hypoplasts may have irregular reproduction from very good to sterile. Single-sided hypoplastic cows had a higher-than-normal fat content of the milk. There was no difference in the inbreeding between hypoplastic bulls, bulls apathetic in copulating, and normal bulls. The data indicate satisfactory agreement with the hypothesis of two recessive hypoplasia genes, which when separate cause single-sided hypoplasia and together double hypoplasia. From an inheritance point of view the right- and left-sided hypoplasia are similar without genetic influence as to side. Sex linkage was not an influencing factor. The frequency of hypoplasia is decreasing in the stock, but it is calculated that it will take three generations to reduce the frequency from 7.9 to 4.5 per cent and about 19 generations (a century) to reduce the frequency to 0.5 per cent.—*Experiment Station Record,* Jan., 1946.

NATURAL SELECTION AND CHROMOSOMAL VARIABILITY IN POPULATIONS OF *DROSOPHILA FUNEBRIS*

N. P. DUBININ and G. G. TINIAKOV

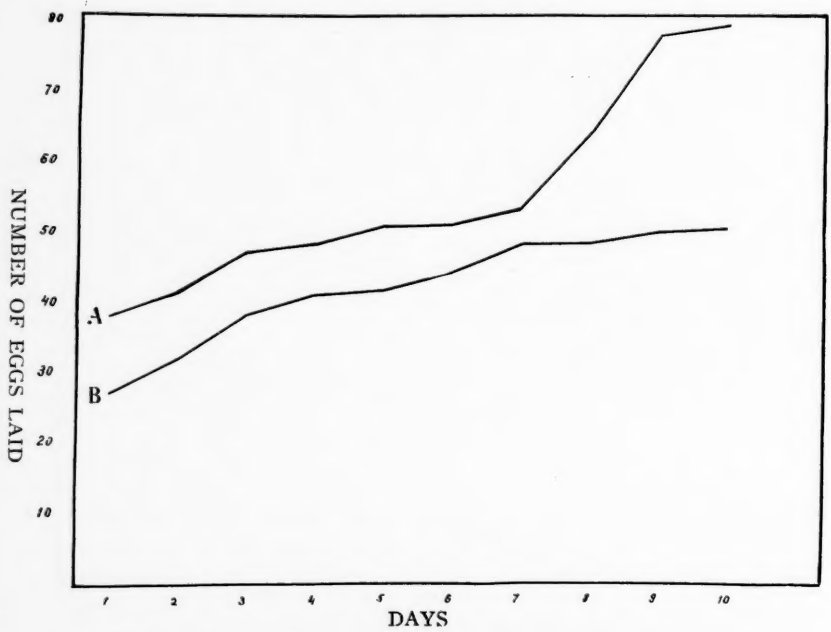
THE development of methods of analysis of Drosophila karyotypes through observations on the giant chromosomes in the nuclei of salivary gland cells had made it possible to approach the problem of chromosomal variability in natural populations. Applying these methods, Dubinin, Sokolov and Tiniakov[3,4] and Dobzhansky and Sturtevant[2] were the first to discover the enormous frequency of chromosomal variants in populations and to elucidate some of the ways in which karyotypic divergence comes about. The differentiation of populations proved to be far reaching. Dubinin and Tiniakov[5] found that urban and rural populations of *Drosophila funebris* differ in the incidence of certain inversions. They investigated four populations of this species from different parts of the city of Moscow, which contained from about 16 per cent to 88 per cent of individuals heterozygous for inversions. A sample of the population from the city of Ivanovo contained 37 per cent inversion heterozygotes. Yet, samples from villages in the vicinity of Moscow and Ivanovo had from zero to two per cent of inversion heterozygotes. Dobzhansky,[1] Dubinin, Socolov and Tiniakov,[3] and Dubinin and Tiniakov[5] found cyclic changes in the incidence of inversions in Drosophila populations taking place from month to month of the year. These authors[5] found that populations of *D. funebris* in Moscow exhibit the lowest inversion frequency after hibernation. The inversion frequency rises in summer when the flies composing these populations reproduce, and attains a maximum when the populations reach the peak of their expansion. During winter the inversion frequencies fall again, and reach the lowest point during spring.

What environmental factors cause the karyotypic pattern of the urban and the rural populations to diverge? Are they the same as the forces which alter the frequencies of inversions in different months of the seasonal cycle? It is fairly certain on the basis of indirect evidence that we are dealing here with effects of natural selection on the structural differentiation of the species karyotype. The development of methods for studying problems of this type is of outstanding importance. The work reported in this paper represents the first attempt to approach this problem directly.

The Influence of Hibernation on the Incidence of Inversions

Experimental analysis of effects of hibernation on the flies was undertaken. Population samples of from 1,000 to 5,000 specimens were placed in special plywood boxes, 30 × 20 × 20 cm. in size, with one glass side and an opening for ventilation in one of the other sides. Such boxes were kept in a cellar at temperatures from —2°C to + 3°C during the winter of 1944-1945. Cytological examinations of the populations were made before they were placed in the hibernation boxes. The aim of these experiments was to compare the frequencies of inversions in the initial populations with those in the hibernating specimens. This should give a direct proof of the action of natural selection on the survival of different components of natural populations.

The initial populations had three inversions in the second and fourth chromosomes. These inversions are denoted II-1, II-2, and IV-1. The populations were allowed to hibernate for one, one and a half, and two and a half months in different experiments. Table 1 shows that very many flies perish during hibernation. Less than one fly per hundred (64 specimens out of the initial 11,452) survived after two and a half months.



SURVIVORS OF HIBERNATION MORE FECUND

Figure 3

Fecundity, in terms of eggs laid per day, of females that had survived hibernation (curve *A*) compared with control females (*B*). The survivors of hibernation are consistently more fecund than flies not exposed to this selective hazard.

The proportions of survivors among females and males are about equal.

The principal questions which must now be answered are whether or not there is differential survival of carriers of different chromosome structures, and whether or not inversion homozygotes and heterozygotes survive at the same rates. The relevant data are summarized in Table II.

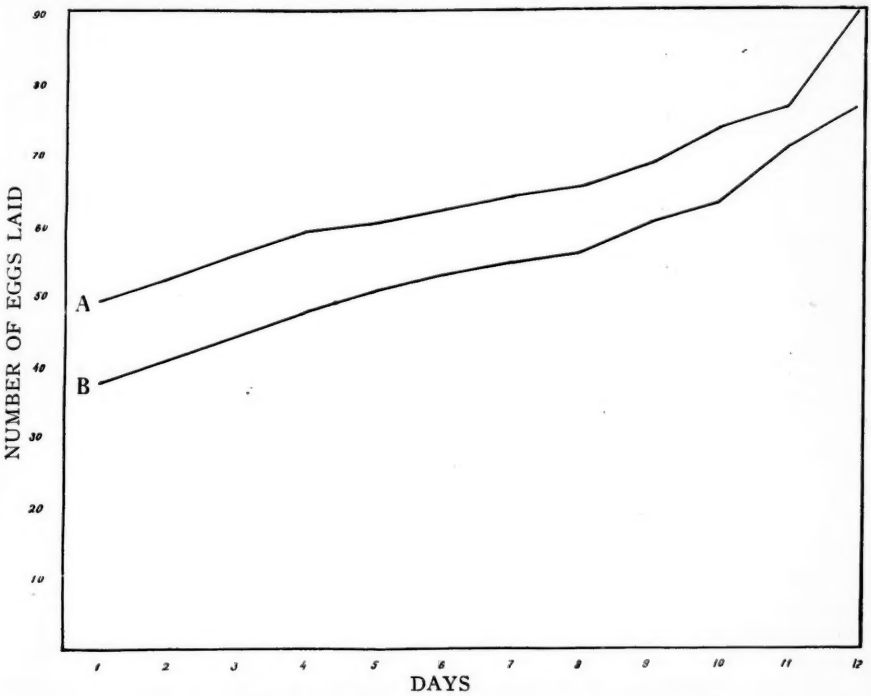
Table II shows that in both experiments the incidence of heterozygotes for inversion II-1 has diminished after hibernation. Individuals homozygous

Table I.—The frequency of survival in *Drosophila funebris* during hibernation.

Origin of population and duration of hibernation	Initial number of specimens	Survivors			
		Females	Males	Total	Per cent surviving
Samoteka - Moscow; Boxes Nos. 10 and 11. One month.	5100	171	176	347	6.80
Samoteka - Moscow and Ivanovo; Boxes Nos. 2, 3, and 6. One and a half months.	5960	83	70	153	2.57
Ivanovo; Boxes Nos. 3, 4, and 5. Two and a half months.	11452	35	29	64	0.56

TABLE II.—Incidence of inversion heterozygotes before and after hibernation.

Population	Not hibernating		After hibernation	
	Number	Per cent	Number	Per cent
Ivanovo:				
Total examined	367	....	72	....
No Inversions	225	61.4	54	75.0
Inv. II-1	116	31.6	10	13.9
Inv. II-2	6	1.6	2	2.8
Inv. IV-1	20	5.4	6	8.3
Samoteka:				
Total examined	261	....	58	....
No Inversions	50	19.1	17	29.4
Inv. II-1	134	51.3	18	31.0
Inv. II-2	70	26.9	10	17.2
Inv. IV-1	7	2.7	13	22.4



SUPERIOR FECUNDITY TRANSMITTED TO DAUGHTERS

Figure 4

The daughters of females surviving hibernation (curve *A*) are consistently more fecund than females that had not hibernated (*B*). This demonstrates that the survivors of hibernation are genetically different from flies not exposed to hibernation.

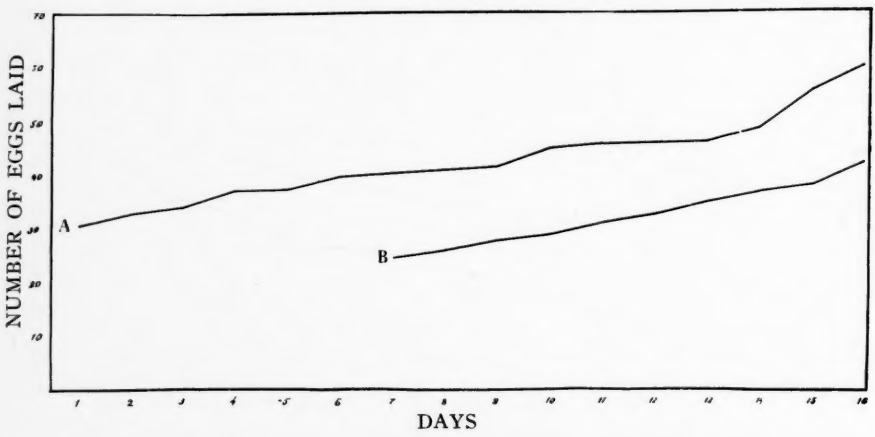
for the normal gene arrangement in this chromosome survive more frequently than the heterozygotes. The behavior of inversion II-2 during hibernation is not clear. After hibernation there were considerably more individuals heterozygous for inversion IV-1 than before hibernation.

These results agree well with what is known about the changes in the inversion frequencies during the different seasons of the year. Namely, the frequency of inversion II-1 rises in summer and falls during winter, whereas inversion IV-1, shows a reverse relation.

Another series of experiments was done with three strains which were known, from previous cytological examination, to have the following structures: (1) homozygous for inversion II-1, (2) homozygous for the standard gene arrangement in chromosomes II, and (3) heterozygous for the normal and the II-1 gene arrangements. Flies of these strains were placed in the hibernation boxes and exposed under hibernation conditions. The experiments lasted for 45 days, with samples being taken on the 15th, 30th, and 45th days. The results are summarized in Table III.

TABLE III.—Survival of different karyotypes of *Drosophila funebris* under conditions of hibernation.

Days of hibernation	Homozygous normal			Inversion Heterozygotes			Inversion homozygotes		
	Initial number	Number survived	Per cent survived	Initial number	Number survived	Per cent survived	Initial number	Number survived	Per cent survived
15	2000	593	24.6	2000	285	14.2	1847	270	14.6
30	3092	367	11.2	2318	94	4.1	3483	147	4.2
45	1092	12	1.1	1483	1	0.1	1471	3	0.2



FECUNDITY OF FEMALES SURVIVING HIBERNATION IN NATURE

Figure 5

The fecundity of females which survived hibernation in natural habitats (*A*) is superior to that of control females (*B*).

Table III shows again that most flies die during hibernation. More important is that the survival of different karyotypic categories is differential. Individuals homozygous for the normal gene arrangement survive more frequently than either heterozygotes or homozygotes for the II-1 gene arrangement. On the other hand, the rates of survival of the inversion homo- and heterozygotes seem to be equal. This suggests that the genes in the inversions which determine the selective values of the respective chromosomes are completely dominant. It would be very interesting to find out the behavior of the factors which determine the differential survival and the consequent increase in the frequency of the inversion during the summer. This is a matter for future studies.

The Fertility Cycle in Populations of *Drosophila funebris*

In the course of the above described experiments on the differential survival of individuals with different gene arrangements during hibernation, it has been noticed that cultures obtained from individual females surviving hibernation are as a rule overpopulated compared with similar cultures obtained from females that have not passed through hibernation. Further studies have confirmed this observation, which is of considerable importance for the understanding of the process of natural selection enacted in the populations.

Out of an original population of 17,629 flies, 217 individuals, or 1.23%, have survived after hibernation lasting from one and a half to two months. The initial material for hibernation was taken from mass cultures of three populations, namely Samoteka-Moscow, the city of Ivanovo, and the village of Spasso-Shelutinsky in the Ivanovo region. The same mass cultures served as controls. The fecundity of 80 females was studied by counting eggs deposited by each of them within an interval of ten days. The age of the experimental females, which had hibernated, was from 50 to 80 days when their eggs were being counted. The corresponding age of the control females was 10 days.

Figure 3 shows the average numbers of eggs (ordinates) of 40 experimental (the upper curve) and 40 control females (the lower curve) deposited by

these females on the different days (abscissae). The experimental females laid a total of 17,364 eggs, and the control ones 15,379 eggs. The egg-laying curve for the experimental females is higher throughout than that for the control females; the former deposit on the average 55.7, and the latter 42.3, eggs per day. The fecundity of an experimental female is 31.7 per cent higher than that of a control one.

The few females that survive hibernation show, then, an increase in fecundity compared to the initial population. How is this phenomenon to be interpreted? One possibility is that a prolonged influence of cold stimulates the reproductive system of the females. The other possibility is that the few individuals that survive hibernation are genetically different from those that do not, and that the higher fecundity is one of the characteristics of the former.

If the latter possibility is true, this is biologically very important in the life of the populations. Indeed, only the few flies that survive the hibernation and appear in the spring are progenitors of the new generations. A high fertility of these flies is favorable for a rapid propagation of the populations of the species during spring and summer.

The problem of whether or not the fecundity differences which we have found are genetic can be approached experimentally. If the high fecundity of the survivors of hibernaton is genetic, then their offspring will also show a high fecundity. If, on the other hand, it is induced by the treatment, the offspring will show the same fertility as that of the control females. Figure 4 shows the average number of eggs deposited by 46 daughters of the females surviving the hibernation (the upper curve), and that of 46 control females (the lower curve). A total of 29,700 eggs of experimental and 25,248 eggs of control females has been recorded. The daily egg laying of daughters of females that survived hibernation is 64.2 eggs, and of control females 54.6 eggs. The increased fecundity of females surviving hibernation is due to genetic causes.

The fecundity of females surviving hibernation in nature is high. We have examined the fecundity of females collected in April in the Botanic Gardens in Moscow, which, since they were the survivors of the autumn brood, were at least 180 days old when caught. Figure 5 compares the egg laying curve of these females with that of control females. The fecundity of the natural hibernating females proves to be 36.6 per cent higher than in the control. It should be noted that females surviving hibernation (both in nature and in experiment) do not deposit fertile eggs except after a fresh insemination by a male; the sperm present in the spermathecae of these females before hibernation presumably fails to survive the hibernation.

Conclusions

Natural selection produces several interesting effects in populations of *Drosophila funebris*. Here belong the differentiation of urban and rural races, the diminution of the inversion frequencies in the populations of cities destroyed by the war, and the existence of changes in the incidence of inversions following the annual seasonal cycle.

The data here presented give for the first time a direct experimental evidence of a relation between the karyotypic structure of a population and natural selection. The hibernation experiments show a differential survival of carriers of chromosomal variants widespread in natural populations. It appears, then, that different gene arrangements react differently to the same experimental conditions.

The analysis of fecundity of females before and after hibernation indicates another element of importance in this situation. We are confronted with a problem of annual cycles in fertility of the flies. The data so far obtained are only the first step in analysis of genetically caused physiological properties of populations. Further work in this field

may produce important results for genetics of populations.

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ARTIFICIAL INSEMINATION COMES OF AGE

ACTIVE interest in artificial insemination for use in livestock improvement first developed in the United States a decade ago. As with any new technique, all initial experiments with it were not successful. Failures resulted from lack of proper financial arrangements in artificial breeding associations, from improper handling of the technique, from over-enthusiasm followed by disappointment when miracles didn't occur, and from other causes. But there were successes, too. Most of those associations that used the technique carefully and in conjunction with a sound program of livestock improvement have prospered. Others have profited by these early successes and the effective use of the technique has expanded rapidly in recent years, particularly with dairy cattle. On January 1, 1945, a total of 342,012 dairy cows were enrolled in artificial breeding associations in the United States, and these associations were using 650 bulls. This is an average of 527 cows per bull.

Clearly visible milestones do not always mark that stage of well-rounded development when the fruits of scientific research pass from the experimental phase and take their places in established practice. But the appearance of a book on such a subject often indicates that the end of the period of experimental adolescence is at hand. That two books on artificial insemination appeared in 1945, may thus be doubly significant. One of them* will be useful primarily as a handbook for field workers and undergraduate students. The other† will be most useful to graduate students and research workers.

The first well-authenticated instance of artificial insemination of a mammal occurred about 1780, when an Italian, Spallanzani, inseminated a bitch to demonstrate that semen alone was sufficient to initiate a normal pregnancy. During the next century, intermittent use was made of the technique as an alleviation of sterility. No real attempt was made to develop insemination as a tool for the animal breeder until 1899, when Professor Elie Ivanov began his work in Russia. In 1909 a laboratory was established for instructing veterinarians in the technique and some field work was done from then until 1913. Interrupted by war, the work was again taken up in 1919, in a Central Experimental Breeding Station in Moscow under Professor Ivanov's direction. Owing to lack of equipment and staff, work on artificial insemination was not started until 1923, but from that time its use was rapidly expanded. The first comprehensive discussion‡ of the technique in English appeared in Great Britain in 1933. This was based largely on the work of the Russians. In 1940 a detailed circular§ on artificial insemination was issued by the U. S. Depart-

*The artificial Insemination of Farm Animals, edited by Enos J. Perry. Price $3.50. Rutgers University Press, New Brunswick, N. J.

†The Semen of Animals and Its Use for Artificial Insemination, by James Anderson. Imperial Bureau of Animal Breeding and Genetics, Edinburgh. Price—7s. 6 d. Central Sales Branch, Imperial Agricultural Bureaux, Penglais, Aberystwyth, Great Britain. 1945.

‡The Technique of Artificial Insemination. Imperial Bureau of Animal Genetics, Edinburgh. 1933.

§Artificial Insemination in Livestock Breeding, by W. V. Lambert and Fred F. McKenzie. U. S. Dept. of Agric. Circular 567. 1940

ment of Agriculture, and bulletins for field use were issued by a number of State agricultural institutions at about the same time.

The book edited by Perry is written for the farmer who wishes to use artificial insemination, and also for the teacher of animal husbandry and the veterinarian. Brief introductory chapters outline the historical aspects, and advantages and limitations. These are followed by chapters in which the organs of reproduction, and the procedures of artificial insemination, as they apply to most classes of livestock, are described. Detailed descriptions of the successful methods used in practice with cattle, sheep, horses (and jackstock), birds and swine are given in later chapters. The descriptions of procedures for artificial insemination are followed by three chapters entitled "Breeding Better Livestock", "Systems of Breeding" and "Selection of Sires". These include discussions of such topics as elementary Mendelian genetics, multiple factor inheritance, lethals, variation, methods of evaluating dairy herds, and methods of breeding, and are designed to acquaint the breeder with some of the basic information on heredity so that he may understand better the problems to be surmounted in livestock improvement. It is natural that emphasis in these chapters is placed on applications of genetics to dairy cattle since the editor of the volume is interested in that class of stock and artificial insemination has been applied to dairy cattle more than to any other class of livestock in the United States. The chapter on selection of sires outlines methods of selecting dairy bulls in some detail but makes only very brief mention of other classes of stock and would be much improved by including at least résumés of the important work on evaluation of meat, fiber and work-producing animals which has been carried out in recent years. Another chapter gives an excellent account of cooperative artificial breeding associations which should be especially valuable to those who contemplate establishing such associations. Concluding chapters deal with shipment of semen, disease in relation to artificial insemination and feeding and management of sires.

Technical workers will find this book inadequate in some respects. Their most cogent criticism will be levelled at the omission of some details and many references to the literature that are almost inevitable in a popular handbook. The field worker and the farmer whose chief interest is the application of technique of artificial insemination will find it a valuable addition to their libraries. The information on field use of the technique and on organization problems encountered in the establishment and maintenance of artificial breeding associations should be especially helpful to field workers.

Anderson's publication contains a comprehensive review of practically all the pertinent literature. It is divided into three main parts. Part I deals with the physiology of semen under the following headings: The semen of animals; Factors affecting semen production; Physico-chemical properties of semen; Physiology of spermatozoa; Storage and transport of semen; Examination of semen. Part II contains discussions of the advantages and limitations of artificial insemination, its application in various countries, and some of the factors which affect its use. Detailed descriptions of the technique as applied to cattle, sheep, horses, pigs, dogs, poultry and other animals are given in Part III, together with a chapter on management of sires. A bibliography of 570 references is included. Any attempt to adequately review the contents of such a well-documented volume could result only in another lengthy manuscript. Anderson, who is stationed at the Experimental Station, Naivasha, Kenya, Africa, has performed a real service by bringing together a vast amount of information in well-organized, readable form.

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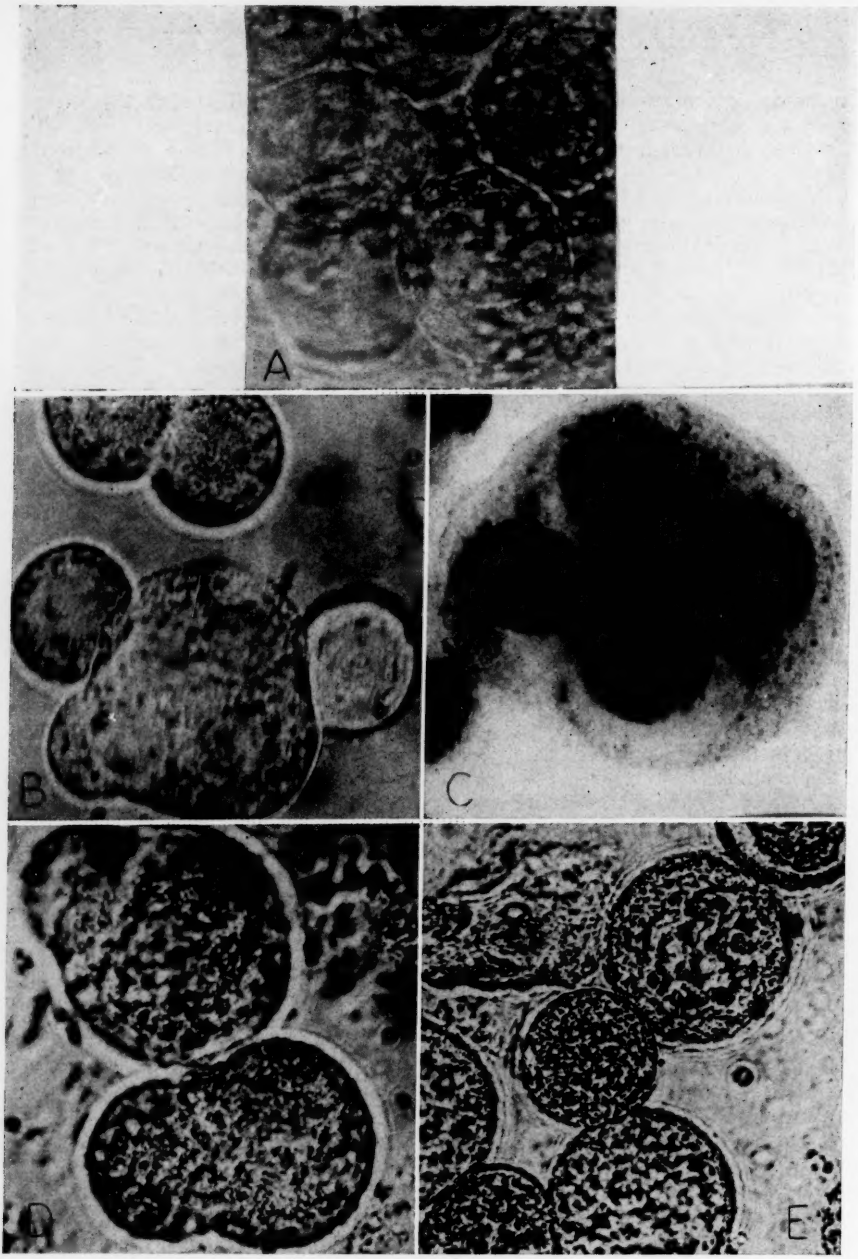


FORMATION OF MULTINUCLEATE POLLEN GRAINS

Figure 6

A—Suspension of pollen mother cells after six days in 0.8M sucrose solution. The cell walls are loosened from the protoplasts and the cells have become spherical. *B* and *D*—Fusion of cells in 1.5M sucrose solution, showing various stages in the process. *C*—Fixed multi-nucleate cell stained in aceto-carmine. Previously it has been suspended in a solution of 0.8M sucrose 0.1 $CaCl_2$. *E*—Multi-nucleate cells at pachytene-diplotene stage, showing single aggregation of chromosomes. The cell in the center is uni-nucleate.

THE FORMATION OF POLYNUCLEATED POLLEN MOTHER-CELLS

In *Trillium erectum**

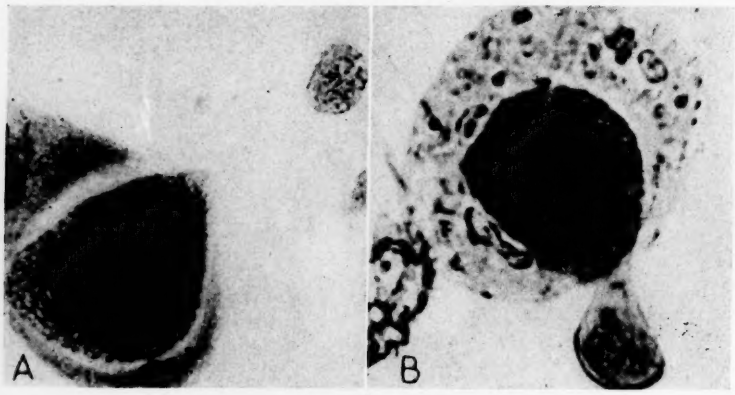
HERBERT STERN
McGill University, Montreal

THE origins of polyploidy are, of course, diverse. The formation of polyploid pollen grains, one such source, has itself been variously interpreted as due to fusion, to lack of spindle formation, or to failure of cytokinesis, though these mechanisms are not mutually exclusive. DeMol,[2] for example, made a comprehensive study of meiosis in the tulip, and concluded that diploid and tetraploid pollen grains were due to the failure of wall formation, Reeves[6] reported a similar condition in some pollen mother-cells of *Zea Mays,* Beadle[1] traced the cause in *Zea* to a recessive gene which, when homozygous, inhibited cytokinesis. Lebedeff[3] reproduced the effect by heat treatments. Levan[5] advanced the alternative explanation for the presence of polynucleated pollen mother-cells in *Phleum pratense,* suggesting cell fusion rather than a failure of wall formation.

That polynucleated cells can arise by a process of fusion is verifiable from direct observation of living cells. Though such observation cannot be made on the pollen mother-cell "in situ," it can be made on preparations cultured in artificial media. The maintenance of viability in such cultures is, however, difficult. The more rapidly dividing pollen mother-cells, like those of *Tradescantia,* have been cultured with limited success in saccharose media (Shimakura[7]), but slowly dividing ones, such as those of *Trillium,* have been found too abnormal when suspended in sucrose solutions to be suitable for extended experiments (Shimakura[8], Gregory[3]). It has been possible, nevertheless, by squeezing the contents of anthers into droplets of pure sucrose solution suspended in moist chamber slides, to obtain preparations of *Trillium* pollen mother-cells which, under appropriate conditions, remain viable for several weeks. These conditions, including stage of meiosis, concentration of sucrose, and pH of the medium, are proper subjects for a more elaborate discussion of the physiology of meiosis and will appear elsewhere.[10] For the present, it is sufficient to point out that pollen mother-cells in the prophase of meiosis (leptotene to diakinesis) when suspended in pure sucrose media ranging from 0.5M to 1.5M (volume molar), or in similar media containing in addition low concentrations (0.05M or less) of NaOH, $CaCl_2$, or NaCl, survive at least for many days and often show polynucleate formation.

It is probable that the conditions promoting cell fusions in artificial media are also effective in nature. At present, no direct confirmation is available, although there is much evidence to justify the assumption. In *Trillium,* only two extra-cellular factors are present naturally which could interfere mechanically with the fusion of cells—the cell-wall and the condition of the anthral sap. The cell-wall, however, becomes very thin beyond leptotene and its disintegration—to judge from its behavior in artificial media—occurs easily. The anthral sap, if a gel, would be an additional mechanical barrier, but the gel condition is present only in the pre-leptotene of meiosis, and from leptotene onwards there is a progressive liquefaction. Apart then from such extra-cellular fac-

*Contribution from the Departments of Botany and Genetics, McGill University, Montreal. Part of work done under grant from National Research Council of Canada.



BREAKDOWN OF GIANT CELLS

Figure 7

Addition of a drop of aceto-carmine alters the acidity of the medium enough to cause breakdown of the cells and an outflow of nuclear substance in preparations undergoing fusions. This behavior is not observed either in normal healthy cells nor in coagulated cells. This instability seems hard to reconcile with the integrity of the fused cells.

tors, which may or may not obtain in other plants, it can be shown that the intra-cellular conditions favoring fusion of pollen mother-cells in artificial media are those likely to result from some of the treatments known to produce polyploid pollen.

Results

Pre-leptotene and leptotene pollen mother-cells suspended in sucrose media lose their external walls after a period of time varying from twelve hours to several days. Cells at later stages of meiosis possess little cell-wall so that the removal, if there is any, is less pronounced. If again, the cells are aggregated in a gelatinous mass, as they are in the pre-leptotene of meiosis, they gradually loosen themselves from it, assume a completely spherical shape, and float about in the solution. (See Figure 6*A*.) Free-floating cells, thus in suspension, may fuse after several days to form multi-nucleated pollen mother-cells. Since the process is rather slow it has been observed and photographed as it occurred in sucrose media (Figure 6*A-D*). The number of fusions possible appears to be unlimited though, actually, cells have not been observed with more than 32 nuclei. These giant cells are completely spherical and appear to be optically identical with the uni-nucleate cells present in the suspension. Their volumes are roughly proportional to the number of nuclei present, indicating that fusions are of complete cells and not of fragments, a fact more directly confirmed from observation of the fusion process. Fixation, unfortunately, generally results in a breakdown of cell structure due to a dispersion of the cytoplasm so that examination of fixed and stained preparations reveals multi-nucleated plasmodial masses such as those found by Levan.[5]

The breakdown of cell structure upon addition of strong concentrations of acid is intimately associated with the peculiar properties of the protoplasm of meiotic cells. In preparations where fusions are occurring results such as those indicated in Figure 7 are frequently obtained by simply adding a drop of aceto-carmine to the suspension. No pressure is applied. The outflow of nuclear substance is always accompanied by disintegration of the cytoplasm. The behavior may appear confusing in view of the integrity of the fused cells. Association of physical lability with fusion tendency is, however, not remote. Neither completely healthy cells nor coagulated ones—these

do not fuse—show a dispersion of cytoplasm upon treatment with acid. A low physical consistency, in fact, would appear to be associated with dispersability, and fluidity of the cytoplasm under conditions favorable to fusion has been demonstrated by micromanipulation. Low consistency is probably one of the more important factors responsible for the fusions. Ordinarily, the pollen mother-cell possesses a peripheral gel layer of variable thickness; the presence of such a layer would obviously inhibit complete fusion.

Dispersability of the cytoplasm results not only from the effects of the medium, but also from the physical state of the normal cell at a particular stage of meiosis. So susceptible are the cells to injury at some stages of meiosis that a dispersion of the cytoplasm occurs after one hour's immersion of the cells in pure sucrose solution without the addition of any reagent. The physical state of the fusing cells is such that cytoplasmic disintegration, though easily effected, does not occur spontaneously in the suspension. The necessary condition can be brought about by the use of suitable concentrations of sucrose, but the effectiveness of sucrose is clearly limited by the stage of meiosis.

Discussion

Two physical properties govern the fusion of cells: surface tension and protoplasmic consistency. Since high surface tension tends to produce minimal area figures it would favor fusion. High protoplasmic consistency (structural viscosity), on the other hand, because of its resistance to change in shape, would oppose the effects of surface tension. It is not always possible, however, to distinguish the effects of each of these components in cellular phenomena. That a high surface tension is present in the cells is indicated by the sphericity of the fusion products. But also free-floating cells which do not fuse are often spherical. Is it necessary, therefore, to postulate an *increase* in the surface energy of the cells to account for the fusions, or is the presence of a peripheral gel layer sufficient to account for the non-fusions? In other words, would all pollen mother-cells fuse in absence of a peripheral gel region?

There is no direct evidence for an increase in the surface energy of fusing cells. It is clear, however, that changes in surface property do occur during meiosis. Tetrads in sucrose solution have been observed to produce hyaline vesicles—a process involving an increase rather than a decrease in surface area. It then, the meiotic cycle is characterized by drop in free surface energy, all other factors being equal, fusions would be characteristic of the early meiotic stages. There is, of course, no evidence to the contrary, but the view is theoretical.

It would appear that the alternative factor, namely, a lowered structural viscosity of the cytoplasm, is at least partly and more immediately responsible for the fusion of the cells. The fluid character of the cytoplasm has been demonstrated by micromanipulation. Certainly, where fusions are common there is little or no detectable peripheral gel layer, a structural feature characteristic of the more stable cells. Furthermore, the fact that all the fused cells attain a complete sphericity points equally to a relatively fluid cytoplasm although the rather slow rate of the process suggests that an appreciable degree of viscosity, true or structural, is maintained.

Physiologically, the state of the cells represents an intermediate stage between normal aggregation and irreversible coagulation. When preparations containing such cells degenerate further, fusions cease. Because the degree of degeneration is roughly parallel by degree of refractivity it is possible to trace the viability of the cell in relation to fusion. The writer has not been able to observe any optically homogeneous or near-homogeneous cells fusing although many such preparations were obtained. Such cells are, in fact, the most viable forms and resemble most closely the natural state of the cells in the anther. Nor do cells which are highly refractive—they are the moribund forms—show any tendency to fuse. Fusions are common only in the intermediate state, and where

such a state can be prolonged fusions continue indefinitely.

Physico-chemically, it is presumed that much of the cytoplasmic protein is in the denatured state[10] so that the substrate is easily precipitated or coagulated. It is in the maintenance of the cytoplasmic protein in a dissolved or suspended state while decreasing its consistency that the required condition for fusion is obtained. Some of the agents which have been applied to anthers to produce polynucleated pollen probably act in such a fashion. Heat, for example (Lebedeff[4]), certainly decreases protoplasmic consistency. Anoxia (Steinitz[9]) would probably in its milder effects decrease the structural viscosity of the protoplasm, although Steinitz believes the polyploidy to be due to a failure of cytokinesis.

It would be valid to assume that under natural conditions aberrations from the normal physical pattern of the pollen mother-cell, such as those described, are possible. In view of the inherent instability of the dividing cell, they are even probable, particularly where any set of abnormal environmental conditions is present. The variations in stability of the meiotic cell make it highly sensitive at certain stages to factors capable of producing physical changes. These factors—temperature, oxygen tension, chemical reagents—may be sufficient cause to produce changes at or near the surface of the cell which promote cellular fusions.

Summary

Pollen mother-cells of *Trillium erectum* when suspended in sucrose media fuse, under certain conditions, to form polynucleate cells. These conditions are related to stage of meiosis and to concentration of sucrose in the medium. The instability of the meiotic cell makes it susceptible to the action of foreign agents such as pure sucrose solutions. One of the principal effects of the sucrose is the reduction of structural viscosity making fusions possible.

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An Appeal From Greece

Gentlemen:

Our country, as you know, has suffered much during the war. The inhabitants of Greece, especially the clerks of Scientific Institutes as the Institute of Plant's Improvements of Thessaloniki (Greece) are suffering much.

I am one of the poorest clerks of the above mentioned Institute, which was cooperating before with you. I have the honour to request you to give my greetings to all of your staff, and ask them to collect any kind of old clothing and shoes and send them to me by mail, for I am the head of a numerous family which has a great need of all the above-mentioned things.

Being sure that you will give your kind help, I thank you, and I promise that I will try to return them in the future.

With great respect,

Irodotos Papadopoulos,

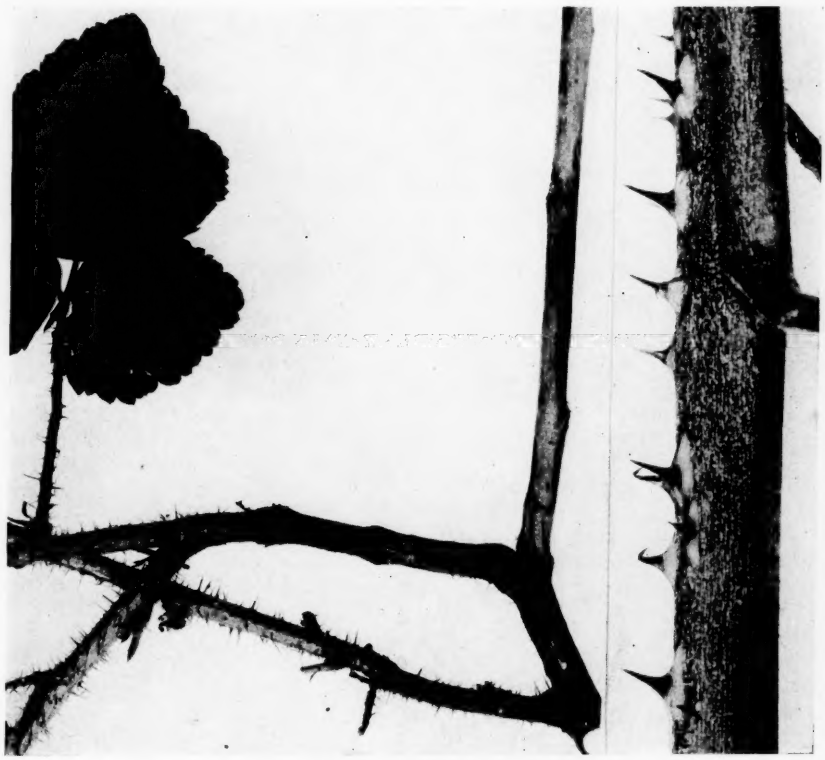
Instituton Kalitereuseos Phiton,
Pavlou Mela St. No. 48,
Thessaloniki, Greece.

Parcel post shipments can be sent to Greece. Weight limit 11 pounds. Mail cannot be insured, and the likelihood of reaching any individual is probably not great. Hence clerk Papadopoulos or the Institute would probably not be swamped if his plea produced several responses.—Ed.

CHIMERAS OF BOWEN BLACKBERRY

An Unstable Patented Plant

J. L. STAHL
University Farm, Davis, California

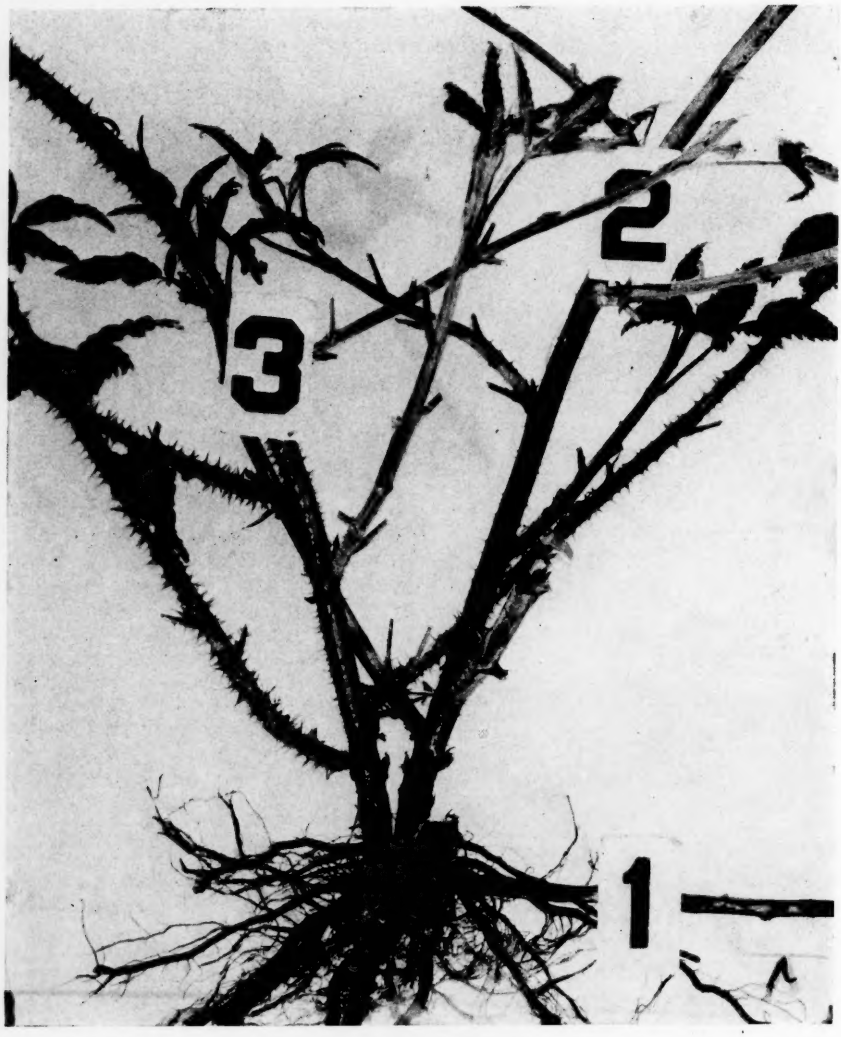


MIXED THORNLESS AND THORNY
Figure 8

The thornless cane on the left has both thornless and thorny shoots. The cane shown on the right has a small island of thorny tissue on the left side. This patented variety appears to be quite unstable in its growth, and the genetic and cytological bases for this are being investigated.

IN the spring of 1944 two plants of the Bowen thornless blackberry, (Plant Patent 635) were secured from Mr. John C. Bowen, Palo Alto, California, and planted at the University Farm, Davis. These propagations are from mother plants Mr. Bowen found growing in the wild near Burlingame, California, and transplanted in his field at Menlo Park. The plants are of trailing habit and are propagated by root-tips as is common with dewberry types. The canes, foliage, and fruits are similar to, if not identical with, the Cory thornless blackberry.

During the summer of 1944 one of the



CHIMERAL PLANT

Figure 9

This is a self-rooted cane from a thornless mother plant. 1 shows the thornless parent cane; 2, a thornless shoot, slightly thorny at the base; and 3, a thorny cane with smooth tissue from which two thornless shoots developed. Photographs by L. R. McKinnon.

plants grown at the University Farm produced one thornless cane with a small area of thorny tissue on one side, (Figure 8) and one thornless from which both thorny and thornless shoots developed, (Figure 8). The remaining canes of this plant were entirely thornless.

The other plant was more erratic. The tips of two thornless canes became covered with soil and self-rooted. One of these resultant plants produced two canes, one entirely thornless and one thorny. The other self-rooted plant (Figure 9) also produced two canes: one thorny, with the exception of a small area of thornless tissue from which two thornless shoots developed, and the other slightly thorny near the base, but mostly thornless.

Further study on the genetics and cytology of this chimera are planned.

COMPOST SALVATION

RODALE* pleads for a system of farming based on the use of organic compost, and, in no uncertain terms, holds that this system is a positive remedy for the many ills of the farm and of mankind. Unfortunately we do not find an objective view of a subject of undoubted importance and interest. To the enthusiastic author the term "chemical fertilizer" is as anathematic as the term "synthetic vitamin" is to the "natural" food faddist. He pays no more heed to the contributions of chemical fertilizers to agriculture than the food faddist pays to an analogous portion of modern nutrition. In both instances the cult of "naturalism" spirals into utter absurdity. Interestingly, in support of his contentions he marshals the testimony of such experts in agriculture and nutrition as Rauschning, the "ex"-Nazi, Carrel, the fascist-infected physician, and Babson, the reactionary economist.

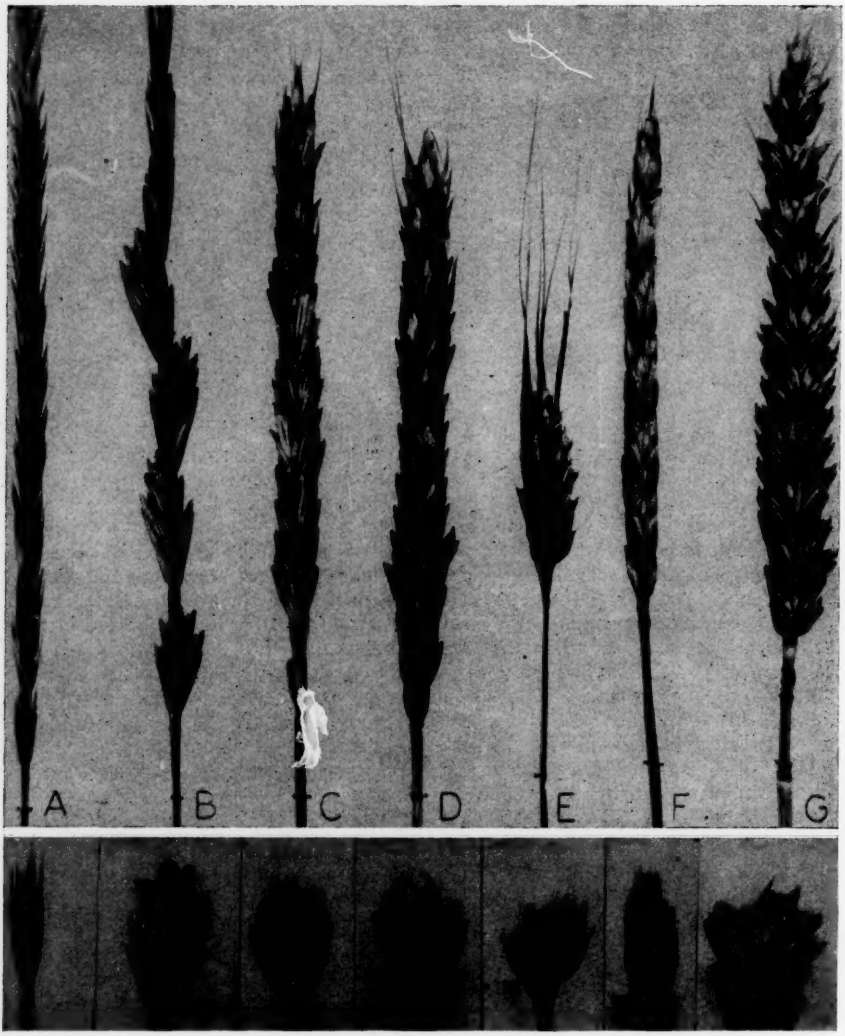
In the part entitled "Health or Disease from Food" which was of primary interest to us, little objective information is presented which shows the relation between the various diseases of man to the composition of crops. Instead we find such phrases as "we are consuming food which is rapidly becoming more and more artificial" and the "use of chemicals goes against Nature." Implicitly or explicitly, compost grown food is the preventive for everything from rheumatism to cancer.

It is regrettable that a more balanced and scientific approach was not adopted to deal with the many problems with which the author is obviously sincerely concerned. The important questions of the neglect of desirable soil characteristics, the danger of chronic intoxication through long continued ingestion of fruits and vegetables containing various chemical spray residues, upsets in the balance of soil life through the use of fertilizers and insecticides—all these and more demand an integrated approach.

The author further fails to point up the great lesson of modern nutrition to agriculture: that the hitherto prime considerations in crop development, namely, yield, disease resistance, and eye and flavor appeal, must now accept nutritional value as a senior partner. Studies which establish the existence of large varietal differences in essential food elements suggest that, like yield and disease resistance, nutritional value is as much a matter of genes as of compost.

MAURICE E. SHILS

*RODALE, J. I. *Pay Dirt.* Devin-Adair Co. Pp. 242. $3.00. New York. 1946.



PARENT AND HYBRID FORMS

Figure 10

Heads and spikelets of *Agropyron, Triticum,* and a hybrid segregate showing *Agropyron* characteristics. *A—A. repens; B—A. junceum; C—Agropyron*-like segregate; D—F_1 hybrid *T. vulgare* × *T. durum; E—T. durum; F—T. Spelta; G—T. vulgare.* In *E,* for clarity, the awns have been clipped off the spikelets facing the camera. The heads are approximately natural size; the spikelets are enlarged about twice.

AGROPYRON-LIKE SEGREGATES

From a Cross Between *Triticum Vulgare* Host. and *T. Durum* Desf.

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IN the F_2 of a cross between a beardless bread wheat, *Triticum vulgare* Host. ($S = 42$) and a liguleless macaroni wheat *T. durum* Desf. ($S = 28$) from the Island of Cyprus, a plant appeared with heads which immediately attracted attention owing to their striking resemblance to the inflorescence of couch grass, *Agropyron*. Judging by the segregation for beards etc., most and probably all of the F_2 family were the result of self pollination, in spite of the fact that the semi-sterile F_1 plants were grown unbagged in a greenhouse containing a number of other wheats. Figure 10*C* shows the head and an enlarged view of one of its lower spikelets; Figure 10*A-B* show heads and spikelets of *Agropyron repens* Beauv. and *A. junceum* Beauv. and Figure 10*D-G* those of a number of wheats for comparison.

At first it was difficult to point out the characters so reminiscent of *Agropyron,* but reflection suggests that in the main they are the peculiarly straight sided glumes markedly V-shaped at the node. The similarity to *Agropyron* is enhanced by the spikelets each containing a number of flowers (possibly on rachillae rather longer than usual) and by the fact that the segregate is rather lax and "beardless" (or more correctly. Tipped —$1B_1B_1b_2b_2$). That it is independent of the keel genes is shown in Figure 10 by (*D*) F_1 *T. Vulgare* × *T. durum* = *Kk*, (*F*) *T. durum* = *KK* and (*F*) *T. spelta* = $K^s K^s$.

A later re-examination of the rest of the F_2 population revealed that another plant was rather similar, although in this case the *Agropyron*-like appearance was less pronounced. Since these two heads appeared in a population of only 22 plants, they are possibly not at all uncommon, yet as far as the writer is aware, they do not seem to have been described before.

As they may have some bearing on the problems of wheat cyto-genetics, they are worth recording in the hope that workers more able to study these aspects than the writer will watch for similar segregates in their material. The plant producing the head illustrated might easily have been a nullisomic, being deficient in both of one pair (or more?) of chromosomes belonging to the *C* set derived from the *vulgare* parent. (*T. vulgare AA BB CC* crossed with *T. durum AA BB* gives the partially fertile pentaploid hybrid (Figure 10*D*, *AA BB C*). Unfortunately at present this possibility cannot be directly investigated because the plant is dead and there is no seed remaining from the F_1 to produce another similar segregate. Sears* described 17 nullisomics, of which 6 are of deficiencies of chromosomes belonging to the *C* set, but none of them corresponds at all to the head under discussion.

*SEARS, E. R. *Genetics* 29:232-246. 1944.

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JOHN INNES HORTICULTURAL INSTITUTION TO MOVE

It is announced that the John Innes Horticultural Institution is to move from the London suburb of Merton to a new site at Bayfordbury, near Hertford. Founded in 1910, this was the first organisation to be set up in England for the scientific study of plant breeding. Since its foundation it has occupied

ten, and latterly twenty, acres of land at Merton. The expansion of its work, particularly in breeding new varieties of fruit, apples, pears, cherries, and blackberries, has made this area insufficient. The new land lies in open country and extends to 572 acres. The move will allow of the freest development in the best surroundings.

The Institution was set up following a bequest of the late Mr. John Innes, of Merton, who died in 1904. It began its work in 1910 under the direction of William Bateson, the pioneer of genetics in this country, and quickly became a meeting place for the leading investigators in this field from all over the world. The second director was Sir Daniel Hall, formerly director of Rothamsted. He was succeeded in 1939 by Dr. C. D. Darlington, who has been chiefly concerned with the development of the chromosome theory of heredity.

Both the theoretical and the practical directions have been followed by the Institution. On the one hand the study of heredity has been deepened and broadened by the work at Merton. On the other hand new varieties of fruits (like apples, cherries and blackberries), and new ways of producing seed by hybridization and selection (as in sweet corn, tomatoes and raspberries) are, from time to time, brought out and made available to the public as a result of the experiments carried out at this Institution. Experiments with the drug colchicine, have opened up new possibilities of plant improvement. These are among the problems being investigated.

Side by side with the work of plant breeding, improvements have been made in the practice of growing plants, particularly in glasshouse cultivation. New methods of soil composting and sterilisation have been introduced, and have been generally adopted by the industry. The new advances have been made widely known, especially since the war, by the publication of leaflets, bulletins and reports. The training of student gardeners, in which the Institution has taken a prominent part, has been conveniently combined with the business of research.

These activities reveal a freedom of development which owes much to the private endowment, the largest of its kind in England. Recently, however, this endowment has proved insufficient for the scale of work necessary under modern conditions. In 1941 too, as a result of air-raid damage, the Institution lost some of its income, and since that time has been assisted by grants from the Agricultural Research Council and the Ministry of Agriculture.

A much larger area and much larger buildings were needed to carry out the work properly. At Bayfordbury, 16 miles north of London, and one mile from Hertford the John Innes Trustees have bought an estate of 572 acres. The soil is good and the country around unspoilt. The mansion of Bayfordbury was built in 1759 and has, until this year, housed the famous Kit-Cat portraits which have now been acquired for the nation. This house, and other buildings, will provide accommodation for enlarged laboratories and for the John Innes library, which is a notable one. The house, and the arboretum as well, which is a collection of national importance, will now be preserved for posterity.

The time of the move from Merton to Bayfordbury will depend on the building position. Dwelling houses will have to be built for the staff, and glasshouses for the experiments in flower and fruit breeding. A year or two will be needed for these preparations as well as for the actual task of moving plantations of trees. When the move is complete, however, the results will be the establishment, virtually, of a new research station suitably equipped to be of service to horticulture, and to the nation at large.

MALABAR FARM IN OHIO

*PLEASANT Valley** is the story of Malabar Farm in Ohio. The farm, several years old, is modelled after the collective farm of Russia and named for the southwest coast of India and a hill overlooking Bombay, for India has been the subject or setting of a number of Bromfield's books which made this agricultural adventure financially possible. This "small cooperative democracy of a thousand acres" in Ohio has served during the war period as an "island of security" against many of the inconveniences and worries of the times, and, aside from the produce marketed, it has brought spiritual and material gains to as many as thirty-five men, women, and children.

Apostle to the City

But *Pleasant Valley* is more than the story of Malabar. It is an extollation of country life and of contact with the soil and with plants and with animals. It is a sermon on the rape of the North American continent and on soil conservation and improvement. It is a point of departure for expression of ideas on agricultural economics and the New Deal. Too, one realizes, it is the medium through which Malabar Farm has been made greatly to pay: the volume I just finished is of the eighth edition, "manufactured in strict conformity with Government regulations for saving paper."

Mr. Bromfield is, by his own admission, "articulate". That is good. For that reason he has reached many people and told them much they should know which they would be long in observing or searching out for themselves in the technical literature. I think he has done a distinct service, and pleasantly so, and often with real feeling. However, some of my farmer friends say that they knew such things already. And indeed much of what he states is obvious. But farmers are a conservative people in their habits and are slow to adopt new practices. Anyway, I suspect that relatively few honest-to-goodness, food-producing farmers of America have read Bromfield; he has probably been most popular in the cities and over cocktail glasses.

Keepers of the Earth

As a "pilot" farm, Malabar, like other farms on which land-utilization programs have been inaugurated, is extremely important. Anything is of the utmost importance that will stir us from complacency about our basic natural resource —the soil. Perhaps our greatest social crime as a nation has been the ravage of our soil. There must not be in the United States any more Ducktown areas or dust bowls. Much land must be reclaimed and rebuilt. The evils of one-crop agriculture must be avoided. The era of crop-mining the land of phosphorus and nitrogen and other elements is about ended: by good farming the supplies must be repleted and maintained. Only if these things are done can our standard of living be kept.

Liberty Hyde Bailey has said that we, as transients exercising a "keepership of the earth", are morally obligated to think of the welfare of future generations. The fertility of the soil has to be one of our chief concerns. The prospect appears not so dark if, like Bromfield, the farmers of this country can build "six to seven inches of good topsoil in five years while growing crops on the same land."† And in the years ahead I hope they will come to have increased appreciation for esthetic values and to relate them to good

*Bromfield, Louis: *Pleasant Valley*. With drawings by Kate Lord. Harper & Brothers. Edition eight. 1945.

†To clarify what seems an over-statement I outline here the basis for the claim as given by Mr. Bromfield. In popular usage, "topsoil" is contrasted with "subsoil" and, in my own thinking, contains some organic matter.

When the experiments at Malabar were initiated, a rolling field was already planted in wheat. The field was of low hills and mounds which sloped in all directions. In some

farming: the full development of the people is far more important than mere economic results—Dr. Bailey has said this. So in America we have a long way to go: there are problems of production, distribution, education, and conservation. And theory must be applied in greater measure to agriculture, for it is my conviction that in the long run the theoretical is the most practical approach to complex problems. What we need are leaders with training and boldness and vision and imagination. Perhaps Louis Bromfield is one of them. Yes, and there must be a government with the vision to support research projects and to guarantee their continuity.

of the low places topsoil was to a depth of three inches; in spots there was none at all. The subsoil was a mixture of clay, sand, and gravel, and of glacial origin. During the first winter the field was limed. In the spring alsike, Ladino, and sweet clovers were sowed in with the wheat. Some of the wheat was not harvested because it was so poor; the rest was combined, and the straw left on the field. With the help of the Soil Conservation Service the field was then laid out in contour strips.

The statement quoted above has particular reference to one of the contour strips 150 feet wide and an eighth of a mile long. In September the strip was plowed, but not well. Weeds, straw, and legumes were simply mixed in the soil, and some of the latter continued to grow. The field was disked but left rough, and wheat was sowed. Some commercial fertilizer was used. And during the winter lime and manure were added. Legumes were again planted. The season was not especially good, but the wheat averaged twenty bushels per acre—a 300% increase over previous years.

Again the legumes and straw were left on the land. In September the strip was ripped up with a tiller equipped with alfalfa knives and disked once. The legumes still grew. Rye and vetch were planted.

In spring the field was ripped up again with a tiller and disked, and oats were sowed. Fertilizer of potassium and phosphorus was added. Somewhat later sweet clover was seeded. Yield of oats was good. By spring there were three or four inches of good topsoil.

In May the strip was deeply plowed. The whole layer of topsoil was turned upside down, and two to four inches of the topsoil and subsoil were brought up. The strip was heavily disked. And corn was planted for ensilage, with soybeans sowed in the rows with the corn. The corn produced two big ears on two thirds of the stalks, and the soybeans were three or four feet high.

The same process of small grain rotation together with intensive leguminization was continued. "At the end of five years we had built six inches of good topsoil, as good—indeed I am not certain that it is not better topsoil than Nature had spent several thousand years in creating."

Fact and Fiction

[illegible] all of *Pleasant Valley* is to my liking. Fiction should not be subjacent to fact [illegible] the impression of scientific accuracy [illegible] created: in this book one feels that the facts are frequently of dubious foundation. And one objects to Bromfield's easy assumption unto himself of knowledge, which sometimes is patently superficial or wrong. For example: about Bromfield's treatment of morels Dr. Alexander H. Smith has written me that "author Bromfield did not look up very much mycological literature before making his comments about what is known of this group. However, due credit should go to him for being a good observer". Repeatedly in reading *Pleasant Valley* I thought of a remark made by Blind Raftery with a wholly different implication but suggestive of Bromfield's attitude: "the weeds none notice, I know their small virtues". And I recall here that Bromfield recognizes Thomas Jefferson as the greatest of farmers. How many would agree? It is amusing at any rate to remember in this connection that Jefferson invented a plow with a mould-board calculated to increase the efficiency of plowing and that he wrote to Charles W. Peale, the portrait painter: "Ploughing deep, your recipe for killing weeds, is also the recipe for almost everything good in farming." Bromfield is an advocate of "trash-farming" and is an admirer of Edward Faulkner of *Ploughman's Folly* fame, so his superlative regard for Jefferson as a farmer is surprising.

In terms of minerally exhausted soils and of resultant human malnutrition, explanation is given by Bromfield for the

bad physiques, morals, and character of of many poor and ineffectual farming people. Admittedly the factor is important, but so are genes and various environmental influences which receive no mention. And he claims that neither from a year in agriculture at Cornell nor from one in journalism at Columbia did he learn "anything at all". Such an accomplishment is impossible, and the more so for a bright boy just off an Ohio farm.

Even though *Pleasant Valley* is a "romantic book", it is written "for the average reader who does not know too much about the earth and what goes on in it and above it," and the author has no right to subject his audience to loose statements. On the contrary, Mr. Bromfield has a heavy responsibility to be truthful and accurate.

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ALBINOS IN PINTO BEANS*

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ALBINOS have been found in almost all major crops, as well as in practically all species of animals, so that references to them are too numerous to mention. In plants, albinos are devoid of all green color and consequently live only until the food material stored in the seed is used up. In corn, albinos are usually produced by one main recessive gene and die before the formation of a fourth leaf.[1] In cotton,[2] yellow seedlings, albinos in effect, die before the third leaf is formed. However, the albino reported here, found in Pinto beans, produces usually the third, fourth, and fifth leaves, all of which are white, before it dies. Probably this extra production of leaves is caused by an abundance of food stored in the bean.

Experimental Results

In 1939, in one progeny in the regular Pinto bean breeding project at the New Mexico Agricultural Experiment Station, two typical albinos appeared out of a total of 40 plants. The cotyledons and leaves were devoid of any chlorophyll, and the plants died about the time of the appearance of the fifth leaf. The progeny, 1203, in which the albinos appeared was an individual plant selection made in a farmer's field in Union County, New Mexico. From this row 38 green plants were saved. However, only nine of these were planted in the field the following year and only five of the nine segregated for albinos.

The records of these segregating families is as follows:

Progeny No.	*Greens*	*Albinos*	*Total*
1308-8	94	25	119
-25	88	31	119
-28	64	21	85
-30	89	24	113
-36	85	29	114
Total	420	130	550
Calculated 3:1	412.5 −7.5	137.5 +7.5	550

In 1941, two of these progenies, 1203-25 and 1203-28, were grown in the field under numbers 1300 and 1301, respectively. These were set aside until the early part of 1945, when seeds of these were planted in the greenhouse and counts made as to green and albino seed-

*The Pinto bean is a mottled, brown and white Mexican bean (*Phaseolus vulgaris*) grown commercially in New Mexico and other western states.

lings. The greenhouse counts of the two families are shown in Tables I and II.* The germination of some progenies was very poor, probably due to abnormal storage conditions. Very great deviations from a 3:1 ratio occurred in some of the progenies.

Of 21 progenies in the 1300 family, 16 segregated for albinos and of 23 progenies of the 1301 family, 19 segregated. The totals of the segregating progenies of the 1300 family are as follows:

	Green	*Albino*	*Total*
Observed	405	148	553
Calculated 3:1	415	138	553
O-C	−10	+10	

The segregating progenies of the 1301 family total as follows:

	Green	*Albino*	*Total*
Observed	319	117	436
Calculated 3:1	327	109	436
O-C	−8	+8	

Since the totals of both families are well within the limits of probable error, the albinos can be explained as being caused by one recessive gene. However, several of the progenies vary widely from a 3 to 1 ratio, and there is a deficiency of the pure green genotype. The possibility that there might be a modifying factor will be further investigated.

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*Tables I and II have been deposited with the American Documentation Institute, as Document No. 2198. Copies can be obtained from The A. D. I., U. S. Department of Agriculture Library, Washington 25, D. C.

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U. S. LOANS AND CHILD BONUSES

The expense of replacing a nation's population is a big part of a nation's national income. Professor J. J. Spengler estimated that the "actual annual cost of replacing the French population must approximate at least $2,700,000,000," or "between one-third and one-fourth of the present French national income." As Russia's population is four times as large as that of France and her birth rate more than twice as high, it may be seen that Russia's birth-rate bill is likely to be very large.

At the present time, Britain, France, and Russia are attempting to acquire loans running into the billions of dollars from the United States. The question may be asked, will these loans be used to help pay bonuses for increasing the populations of those countries? It is one thing to make loans to help feed, clothe, and house needy peoples, but it is quite a different thing to make loans which are likely to help increase the number of needy people in the future, which might lead to greater population pressure, social unrest, and more wars for expansion.

The evidence available suggests that not Britain, France, Russia, nor any other country in Europe or Asia needs a larger population. Before World War II, the continent of Europe had to import 10 per cent of its food supplies, and even then the level of living of European peoples was much lower than that of the United States. This condition contributed to making Europe a hotbed of intrigue and war; and faster population increase now, especially if it is directed by national governments, can hardly help but make conditions worse.

It would appear that the United States should be keenly interested in these matters. It was the United States that supplied the bulk of the resources for two World Wars; and it would be ironical indeed if the United States were to supply the resources for population races which would lead to a third world war, the expenses of which would have to be borne again by the United States, even if the war were not directed against us.—G. I. Burch in *Population Bulletin,* Nov., 1945.

INHERITANCE OF INDETERMINATE GROWTH IN MAIZE

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INDETERMINATE growth has previously been reported in maize by Reeves and Stansel.[4] In that instance the authors found no regular mendelian ratio of normal to indeterminate plants, and they concluded that the appearance is sporadic and influenced by environmental conditions.

The indeterminate growth reported here behaves as a mendelian recessive and the genetic symbol *id* is suggested. The first occurence of *id* plants was observed in 1939 in a field of Connecticut 31, a strain of inbred sweet corn being increased for use in hybrid seed production. When the normal plants were ready for harvest there was a considerable number of very tall plants still growing and showing no sign of ear or tassel (Figure 11). As many as 30 nodes were counted in some plants, whereas the normal plants had less than ten. The history of the C31 inbred may shed light on the origin of the *id* gene. C31 is essentially a Purdue 39 inbred with a larger ear and stalk. C31 was secured by crossing P39 with Long Island Beauty and backcrossing three times to P39. Sib pollinations were made then and seed of the resulting ears was planted in a small isolated plot in 1938, and plants allowed to interpollinate. Seed from this field was used to produce the increase field in 1939 where *id* plants first appeared. It is not posible to say whether the *id* gene arose as a mutation during the breeding process or whether it was in the Long Island Beauty stock used in producing C31. Nothing like the *id* plants has ever appeared in Purdue 39. Neither have they been noticed in Long Island Beauty, but they could have been in this variety for some time without being observed since Long Island Beauty is a very late, rank growing, sweet corn and any *id* plants would probably escape notice of the casual observer. It is our belief that the *id* gene was in the stock of Long Island Beauty used in this breeding program.

The *id* factor is a monogenic mendelian recessive. The ratios obtained show a slight excess of the recessive plants. Prior to 1943 exact counts of normal plants in segregating rows were not made. However, our system of planting and thinning insures a perfect stand so it is possible to get a fairly accurate picture of the percentage of *id* plants since the number of *id* plants was noted in segregating rows. Such counts for the years 1940-1942 showed 29 *id* out of an approximate total of 138 plants, or 21 per cent. Here there was a slight deficiency if we indeed had a perfect stand in all rows. In 1943 we counted a number of segregating progenies and obtained the results shown in Table I.

The Chi-square for this deviation is 4.80 and is between the 5 per cent and 1 per cent point in significance. This is barely significant showing perhaps a significant excess of *id* plants. If we combine the 1943 results with the somewhat less accurate previous results we get a total of 319+:121 *id* whereas the expected is 330:110 or a deviation of 11 for each class. The Chi-square for such a de-

TABLE I.—Indeterminate (id) and normal plants in segregating F_2 progenies in 1943

1943 Row No.	+	*id*	Total	%
4053-56	50	22	72	30.6
4057-60	44	23	67	34.3
4061-64	49	19	68	27.9
4065	14	5	19	26.3
4067-68	22	10	32	31.2
4069-71	31	13	44	29.5
Total	210	92	302	30.5
Expected	226.5	75.5		
Deviation	−16.5	+16.5		

INDETERMINATE AND NORMAL SEGREGATES
Figure 11

C31 plants at harvest time in 1939. Normal plants had produced ears shown in baskets while indeterminate plants (*id*) are still growing. Lower leaves were removed to show shortened internodes. Indeterminate plants grew until killed by frost.

viation is 1.47 showing no significant deviation from a 3:1 ratio.

The *id* corn plants described here are analogous to the indeterminate tobacco plants studied by Jones.[3] However, the genetic ratios obtained by Jones were not in as good agreement with a monogenic ratio as the results reported here. Jones found a considerable deficiency for the indeterminate tobacco plants, there being only 230 out of a total of 8609 or 2.7 per cent, although Allard[1] obtained a

GROWTH HABITS

Figure 12

Indeterminate C31 plant growing between two normal ones. Notice ears on normal plants while *id* plant was still in vegetative state. Corn was planted on December 31, 1942 and photograph made April 30, 1943.

good 3:1 ratio for the same or a similar character. He obtained 439 intermediate plants in a total of 1,820 whereas 455 were expected, not a significant deviation from a 3:1 ratio.

Garner and Allard[2] found the indeterminate tobacco plants could be made to flower by growing in a shorter day. Jones found the same thing and secured seed during the winter months when plants were transplanted from the field to the greenhouse. It seems likely the *id* maize plants are similarly affected by a shorter day. In 1940 two *id* plants were transplanted to the greenhouse at the end of the normal growing season. Although the plants were infected with smut and also infested with corn borers one plant produced a small tassel by December 1, but no viable pollen was obtained. In another experiment, seed of a segregating C31 ear was planted in the greenhouse on December 31, 1942, when the days were short. The normal plants from this progeny developed ears and tassels while the indeterminate ones made only vegetative growth in the greenhouse with no indication of tassel or ear. A good comparison of normal and *id* plants is shown in Figure 12. The *id* plants were transplanted to the field late in May, 1943, and several of these produced tassels with pollen. No ears developed. After the tassels had shed pollen the glumes developed abnormally long, almost like small corn leaves.

Small roots, similar to brace roots, appeared at the base of the glumes. Efforts to propagate these small plant-like structures on the tassel failed. The tassels on the *id* plants are probably similar to those on the abnormal plants of Reeves and Stansel.[4]

Tests have not been made to see whether heterozygous *id*/+ plants showed any greater vigor than the normal ++ plants as reported by Jones[3] for tobacco. If there is any difference it is not very striking since rows segregating for *id* have not been noted as taller or higher yielding than ++ rows. An exact test is needed to determine whether any heterosis is present. No data demonstrating linkage of *id* with other genetic factors has been found.

Summary

An indeterminate corn plant has been found in the C31 sweet corn inbred in maize. This character is a simple mendelian recessive and has been given the genetic symbol *id*. In segregating progenies of *id*/+ plants, the F_2 generation gives 3+:1 *id* as is expected. A slight excess of *id* plants occurs but probably not a significant excess. No linkage has been found.

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British Plans to Balance Births

Advice to the Royal Commission on Population is given in a lengthy memorandum submitted to it by the Eugenics Society of England. The appeal stresses "the importance of taking qualitative considerations into account when devising a positive population policy."

One of the aims of eugenics, the communication sets forth, is "to secure the largest number of births from the most intelligent families in every social and economic class." It cites surveys showing that the least intelligent families have about three times as many children as the most intelligent, and calls for the reversal of this trend as a primary objective of any demographic program.

"To plan the births of a well-spaced family demands intelligence, foresight and restraint," it says, "made in the full light of all relevant medical and genetic factors. When these factors are seriously adverse, children will not be wanted by morally responsible parents." Race suicide, it argues, will not be brought about by a universalized knowledge of how to prevent pregnancy; it "is the love of children that has resulted in a restriction of their number, good prospects for a few being preferred to poverty for many."

The memorandum, which appears in the October *Eugenics Review*, recommends early marriage, guidance on problems affecting marriage and parenthood, and allowances for children proportional to family income. — *Birth Control News.*

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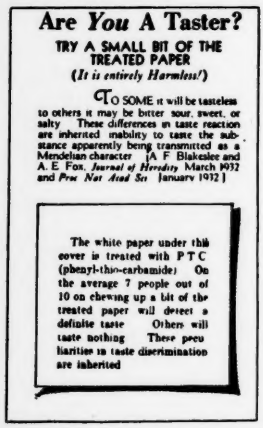
We Regret the Delays

The evil that war does to publication schedules surely has lived after it in recent months. When V-J day arrived we all expected that the worst was over and that almost overnight conditions would improve. In so many ways this pleasant dream has proved to be an illusion. Things were always complicatedly touch and go in the editorial office of the Journal during the war years. We were never sure just what tomorrow's W.P.B. orders regarding paper would bring, but somehow it all worked out. We came nearer a dead stop during January and February 1946 than at any other time. After several bouts with 'flu, and no office help, the Editor belatedly released the Jan. issue to print on Feb. 15. It was finally mailed over a month later. With this issue we hope to gain some of the lost ground, and we *hope* things look brighter ahead. If they don't pan out that way, somebody's going batty. War was never like this!—R. C.


Are You A Taster?
TRY A SMALL BIT OF THE TREATED PAPER
(It is entirely Harmless!)
TO SOME it will be tasteless to others it may be bitter sour, sweet, or salty These differences in taste reaction are inherited inability to taste the substance apparently being transmitted as a Mendelian character (A F Blakeslee and A. E Fox, Journal of Heredity March 1932 and Proc Nat Acad Sci January 1932)
The white paper under this cover is treated with P T C (phenyl-thio-carbamide) On the average 7 people out of 10 on chewing up a bit of the treated paper will detect a definite taste Others will taste nothing These peculiarities in taste discrimination are inherited

LEAFLETS TO DEMONSTRATE HEREDITY

Last year the "Taster test" served as an introduction to human genetic differences in many classrooms. The test is so easily made with the treated paper, and arouses such great interest that it appears to have a definite place in group demonstrations of such differences. These leaflets, size 3⅜" by 5½", are available in quantities for those who wish to use them for classroom or lecture purposes. On the back is printed an outline 4-generation pedigree chart. Sample on request. Prices: 10 for 25c; 50 for $1.00.

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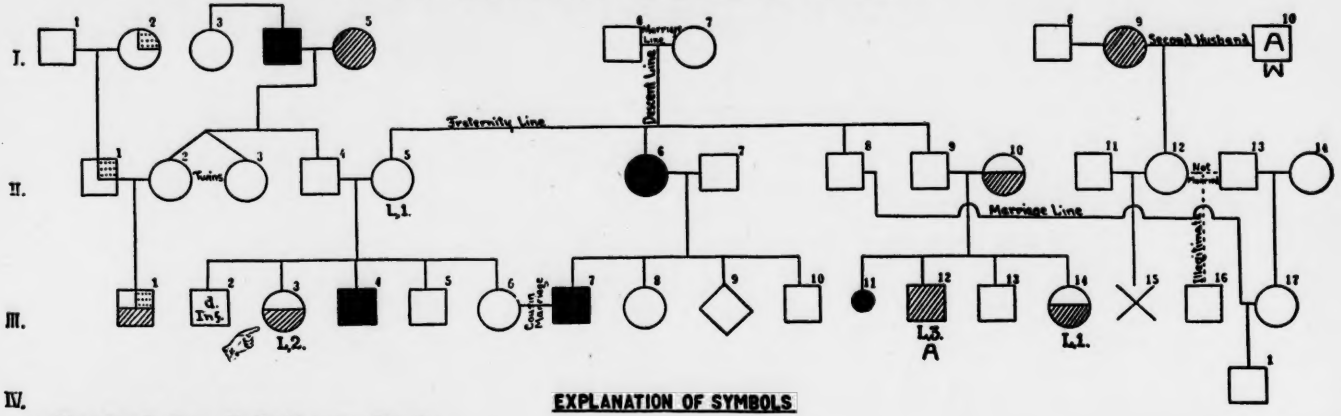
SAMPLE PEDIGREE CHART SHOWING THE MANNER OF CONSTRUCTION, AND THE USE OF STANDARD AND SPECIAL SYMBOLS.



EXPLANATION OF SYMBOLS

(a). **Standard for all Pedigree Charts:**

□=Male; ○=Female; ◇=Sex unknown; ●=Still-birth or Miscarriage; X=Children — number and sex unknown; ○○=Twins; d. Inf.=Died in Infancy; ☞ Points to the Propositus or central figure in the pedigree.

□—○=Parents.

□○□○○=Children.

Roman figures to the left indicate generations; Arabic figures locate individuals, (thus III. 7 is the young man in the third generation who married his cousin).

The following letters, placed in or around the individual's pedigree symbol, are standard for certain traits: A, alcoholic; B, blind; D, deaf; E, epileptic, F, feebleminded; I, insane, M, migraineous; N, normal in reference to traits under consideration; Ne, neurotic; P, paralytic; Sx, sexually immoral; S, syphilitic; T, tuberculous; W, wanderer.

(b). **Especially devised or selected for this particular pedigree-chart:**

■ ● = Successful leaders in politics. ◱ ◔ = Extra thumb on right hand. L.1.=Highly successful author. L.3.=Little or no ability in literary efforts. ▨ ▨ = Superior in vocal music. ▨ ▨ = Medium attainment in vocal music.

To fit the particular family and traits (whether physical, mental or temperamental; good or bad) under consideration, invent special symbols, or select special letters (in addition to those standardized under (a) above) to be placed within or near the particular individual's pedigree symbol, to indicate particular traits and their degree of development.

Prepared by the International Commission of Eugenics. See *Journal of Heredity* for August 1926. Additional copies may be obtained from A.G.A.